

as it was unknown to the fishermen, Capt. Macdonald fortunately preserved it. Through the kindness of Lieut.-Colonel W. Gostwyck-Gard the well-preserved skin found its way to me for identification, and the following diagnosis of the species is taken from it:—

$$D. 7 \frac{1}{31}. \quad A. 2 \frac{1}{26}.$$

The shape of the fish is that of a Horse-Mackerel, but it is fuller, reminding one of a Pilot-fish, which it also resembles in the small size of its scales. The mouth is rather wide, the maxillary extending to the hind margin of the eye; both jaws are armed with a series of rather strong teeth, distantly placed. The dorsal spines are short and feeble, the anterior dorsal and anal rays forming a distinct lobe. Caudal deeply forked. Upper parts of a greenish-black hue, lower parts silvery, these two colours forming, where they meet, deep indentations by which they are dove-tailed into each other.

By this peculiar coloration the fish can be recognized at a glance. Like other species of *Lichia*, it feeds chiefly on fishes of the Herring family, and the specimen here described was no doubt in pursuit of its prey at the time of its capture.

6. Note upon the Green Cells in the Integument of *Æolosoma tenebrarum*. By FRANK E. BEDDARD, M.A., F.Z.S.

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(Plate V.)

This Worm has been described by Vejdovsky ('Thierische Organismen der Brunnenwässer von Prag' (Prag, 1882), p. 61, and also 'System und Morphologie der Oligochaeten' (Prag, 1884), p. 21)¹ as new, but it may possibly be identical with *Nais aurigena* of Eichwald ("Erster Nachtrag zur Infusorienkunde Russlands," Bull. Soc. Imp. Nat. Moscou, t. xx. 1847, p. 359). It has appeared lately in great numbers in a tank at the Society's Gardens, near to that which produced a new species, *Æolosoma headleyi* (see my paper "Observations upon an Annelid of the Genus *Æolosoma*," Proc. Zool.

¹ An American naturalist, Mr. F. W. Cragin, has recently described two species of *Æolosoma* ("First Contribution to a Knowledge of the Lower Invertebrates of Kansas," Bull. Washbourn College Lab. 1887, no. 8, p. 31), and as the periodical is perhaps not generally accessible, I take this opportunity of calling the attention of systematists to the paper. The first species is named *Æ. stokesi*, but I cannot discover any characters by which it can be differentiated from *Æ. quaternarium* or *Æ. chrenbergii*. The chief points in the description are as follows:—"Body cylindrical . . . with eight articulations ornamented with bright salmon-red nuclei . . . most numerous near extremities; setal fascicles in four rows . . . each fascicle . . . with four or five unequal simple bundles."

The second species, *Æ. leidyi*, appears to be new and to be a near ally of *Æ. tenebrarum*. It has "pale olive-green nuclei," and possesses "sigmoid spine-like setæ" in all the seta-bundles; in the posterior segments the fascicles are composed entirely of these setæ. In *Æ. tenebrarum*, as stated above, these setæ are *only* found in the posterior bundles.

Soc. 1888, p. 213). I am also able to take this opportunity of announcing the occurrence in Ireland of Vejdovsky's species *Æolosoma variegatum* (" *Æolosoma variegatum*, Prispěvek ku poznání nejužších Annulatur," SB. böhm. Ges. Wiss. 1885), of which some examples were kindly forwarded to me by Prof. Howes, who had himself received them from Prof. Hartog, of Cork. A comparison of *Æ. tenebrarum* with *Æ. variegatum* has convinced me that, as I stated in my paper, the affinities of *Æ. headleyi* are with the latter species. In both these forms the epidermic coloured cells are bright green, while in *Æ. tenebrarum* they range from greenish yellow to brownish olive. *Æ. tenebrarum*, furthermore, differs from all other species of the genus in possessing J-shaped setæ in the posterior segments of the body, in addition to the hair setæ present in those segments and elsewhere: the setæ are stated by Vejdovsky (*loc. cit.*) to be bifid at the free extremity, but I have not been able to see this in my specimens; in Vejdovsky's specimens the epidermic coloured cells are of a pale yellow, contrasting therefore with the specimens studied by myself, which I am unwilling, however, to refer to a new species since they agree in all other particulars with *Æ. tenebrarum*.

This species of *Æolosoma* is extremely hardy if supplied with sufficient food. I have a large number of specimens which go on multiplying rapidly in a small bottle containing duckweed and a thin layer of vegetable débris at the bottom; the worms have remained in this small vessel for several months, although there is a tolerably thick scum of *Leptothrix* and *Bacilli* upon the surface.

On the other hand, if deprived of food they soon die; three specimens placed in a watch-glass containing water from the vessel in which they lived, but no appreciable quantity of vegetable débris, died in an hour and a half. The watch-glass was placed on a window-sill of north aspect. In these particulars *Æ. tenebrarum* contrasts with *Æ. variegatum*. I placed the specimens of the latter species in a bottle with abundant food; the water and the duckweed were obtained from a locality where there were no specimens of *Æ. tenebrarum*; one or two examples of the latter were, however, introduced by means of a pipette; these multiplied to a great extent, and I have not been able since to discover a single specimen of *Æ. variegatum*.

The green-coloured spots of *Æ. tenebrarum* are large cells with a thin peripheral layer of protoplasm containing a nucleus; in the centre is a large globule of oily appearance impregnated with the colouring-matter. Vejdovsky has remarked (*loc. cit.* p. 65) that the globule is stained black with osmic acid, thus proving it to be of an oily nature. I have found that osmic acid produces a dark brown stain.

The green colouring-matter naturally suggests chlorophyll; and Zacharias ("Studien über die Fauna des grossen und kleinen Teiches im Riesengebirge," Zeitschr. wiss. Zool. Bd. xli. pp. 499-500) states that in an *Æolosoma* (probably *Æ. variegatum*) he observed the green bodies dividing, and therefore considers that they may be parasitic algæ. With a view to discovering whether the bodies

in question were really coloured by chlorophyll, I kept a number of individuals in the dark for a considerable period (14 days), but without any change being apparent in the green bodies. This is not, however, a conclusive argument, since von Graff ("Zur Kenntniss der physiologischen Function des Chlorophylls im Thierreich," Zool. Anzeiger, 1884, p. 520) found that in *Hydra* kept in complete darkness for one hundred and nine days "there was no alteration either in the form or in the colour" of the chlorophyll-corpuscles.

Being unable to extract a sufficient quantity of the green pigment for spectroscopic investigation, I treated the living worm with solution of iodine (both alcoholic and in iodide of potassium) and obtained a very remarkable reaction.

The cells containing the green oil-drops are stained of a deep blue-black colour by iodine; the colour can be seen to gradually spread over the cell and to be limited to the peripheral protoplasm; almost as soon as the colour is developed it rapidly disappears, leaving the protoplasm stained yellow. I found it impossible to retain the stain for more than a few moments. If the worm was first killed by acids, &c., this iodine reaction did not take place; it is therefore evidently produced by the living protoplasm only. Although there is a certain resemblance here to the starch-reaction, the fact that the blue-black staining could not be produced after the death of the cells is against such an interpretation. I am inclined to think that the appearances described are produced by the deposition of elemental iodine, which is rapidly redissolved after the influence which caused its precipitation is withdrawn by the death of the cell¹.

I should be extremely glad if it could be found that the iodine reaction was characteristic of starch (or some carbo-hydrate), as I could then announce the formation of this body in cells coloured green by a substance that is *not* chlorophyll (I shall show this presently); this would be a very strong argument in favour of Pringsheim's "screen theory."

When the living worm was treated with various acids, the colouring-matter was dissolved out, often expelled with violence from the body; in the latter case the oily vehicle of the colouring-matter took the form of a fine coiled thread, thicker at one end; there were all gradations in form between this and an oval; the same effects were produced by crushing the worm. When the colouring-

¹ When a living example of *Æolosoma tenebrarum* was treated with Stokes's fluid, it was killed almost immediately, but no universal change of colour could be detected in the green bodies; when the worm was subsequently treated with iodine, the black reaction was produced, which lasted a very much longer time than when the living worm was submitted to the action of the same fluid. On treatment with alcohol, the black staining *immediately* vanished and the worm was decolorized. This seems to suggest that although the worm is killed by the treatment with Stokes's fluid, the green cells are not at once killed by that reagent—not so rapidly as they are by solution of iodine; and also it seems to prove that the precipitation of the iodine (if I am right in supposing that this is the nature of the black stain) is a function of the living cell.

matter, after being liberated from the cells containing it, was treated with an alkali (ammonia and potash were used), it altered its colour into a fine reddish purple; this could be changed back again into a yellowish green by treatment with mineral acids. When the coloured cells were treated by an alkali *in situ*, their colour changed gradually to a dirty brown; they never exhibited the fine purple hue shown when the pigment was expelled from the cell. The pigment was dissolved by turpentine forming a gamboge-yellow solution, which soon faded; this could be converted into violet by alkali. These reactions appear to show that the green pigment in *Æolosoma tenebrarum* is not chlorophyll.

It resembles, in fact, in the changes of colour produced by alkalis and acids, certain pigments described by Moseley ("On the Colouring-matters of various Animals, and especially of Deep-sea forms dredged by H.M.S. Challenger," Quart. Journ. Micr. Sci. vol. xvii. 1877, p. 1) and other observers, and is possibly a member of that numerous class of pigments which serve a respiratory purpose. It is curious that the colour of the pigment, dirty green when acid, and purple when alkali, appears to be more like that of the perivisceral corpuscles of *Spatangus purpureus*, as described by Geddes ("Observations sur le fluide périviscéral des Oursins,"¹ Arch. de Zool. Exp. t. viii. (1879), p. 483), than any other pigment of which I can find a description. In neither *Bonellein* nor *Chlorocruorin* does there appear to be, judging from the papers of Sorby ("On the Colouring-matter of *Bonellia viridis*," Quart. Journ. Micr. Sci. vol. xv. 1875, p. 169), Lankester (Journal of Anat. & Phys. vol. ii. and vol. iv. 1870), and MacMunn ("On the Chromatology of the Blood of some Invertebrata," Quart. Journ. Micr. Sci. vol. xxv. 1885, p. 469), a change of colour exactly like that of the green pigment of *Æolosoma*; and these are precisely the pigments which one would be, *à priori*, disposed to compare with that of *Æolosoma*, since they are Annelid pigments. However, in the absence of spectroscopic data, it is impossible to make any comparisons of great value.

Bonellein, which is a green pigment, is converted into violet by the action of acids; it evidently therefore differs materially from the pigment of *Æolosoma*. According to MacMunn (*loc. cit.* p. 478), chlorocruorin, when treated with an alkali after rectified spirit, became yellowish. I could not obtain this reaction, as the alcohol decolorized *Æolosoma tenebrarum*².

The pigmented cells of *Æolosoma* are by no means unlike those of *Thysanozoon*³ (see Lang, "Die Polyclader," Naples Monographs,

¹ This pigment appears to be Echinochrom (see MacMunn, "On the Chromatology of the Blood of some Invertebrates," Quart. Journ. Micr. Sci. vol. xxv. (1885) p. 483.

² There are other green pigments of course, about which, however, nothing appears to be known, except that in some cases (*e.g.* those of *Trocheta*, *Phyllo-doce*) they yield no absorption-bands.

³ While working at the Plymouth Biological Station in August 1888 I observed a Planarian with large green spots exactly like those of *Æolosoma* (so

pl. 9. fig. 9), in many of which the pigment is collected into a globule lying in the middle of the cell; this globule is, according to Moseley ("On *Stylochus pelagicus*, &c.," Quart. Journ. Micr. Sci. vol. xvii. 1877, p. 30), of a fatty nature, which is a further point of similarity to *Æolosoma*.

A resemblance—perhaps of greater importance—is shown to *Ctenodrilus*; this genus consists of three species, in all of which the integument is dotted over with coloured spots. In *Ctenodrilus monostylos* (v. Zeppelin, "Ueber den Bau und die Theilungsvorgänge des *Ctenodrilus monostylos*," Zeitschr. wiss. Zool. Bd. xxxix. p. 617) and in *Ct. pardalis* (v. Kennel, "Ueber *Ctenodrilus pardalis*," Arbeit. Zool. Inst. Würzburg, Bd. v. 1882, p. 375) these spots are dark green. In the third species, *Ct. parvulus*, Dr. Scharff ("On *Ctenodrilus parvulus*," Quart. Journ. Micr. Sci. vol. xxvii. 1887, p. 592) states that the spots are dark green or violet, and that the colouring-matter is carried by an oily substance. I am not quite clear from Dr. Scharff's paper whether he means to say that the colour of these spots in *Ctenodrilus parvulus* is violet, or whether green and violet spots both occur. In any case, the alternation of green and violet is most suggestive in the light of what has been already said regarding the change of the green pigment of *Æolosoma tenebrarum* into violet by an alkali: moreover, Prof. Hartog informs me that he observed "claret-coloured" spots as well as green in one individual of *Æ. variegatum*; this fact is evidently of importance. Moseley's observations upon the blue and red colouring-substances of two land-planarians found at Sydney, N.S.W. ("On the Colouring-matters," &c., loc. cit. p. 11), suggest, however, the need for caution in drawing such an inference; he found that the blue pigment of one of the worms was converted into red by the action of acids, and surmised therefore that the red pigment of the other species would prove to be identical with this pigment; but this surmise proved to be incorrect.

I have already suggested that the green pigment of *Æolosoma tenebrarum* may be a respiratory pigment, capable of oxygenation and deoxygenation; the peculiar reaction with iodine which has been referred to may possibly fit in with this hypothesis. I may also mention that the change in colour of the cells from a bright yellow-green to a dull olive-brown is very suggestive of a corresponding taking up and giving off of oxygen, but I have no positive facts to offer, and the proof is indeed extremely difficult.

The blood of *Æolosoma tenebrarum* is quite colourless at all times. The plasma of the blood of *Æolosoma quaternarium* and *Æ. ehrenbergi* is stated by Vejdovsky (loc. cit. p. 18) to be colourless; but he describes cells with branched processes attached to the walls of the dorsal vessel in these species and in *Æ. tenebrarum*, which contain a yellow pigment. This may be hæmoglobin, but there are no obser-

far as I can remember). I made a few notes upon the worm, which I have unfortunately lost; I hope, however, to have an opportunity of finding the Planarian again. It was not *Vortex* nor *Mesostomum* nor *Convoluta*.

variations known to me upon the presence or absence of this colouring-matter in the blood of *Æolosoma*. Lankester ("A Contribution to a Knowledge of the lower Annelids," Trans. Linn. Soc. vol. xxvi. p. 642) has mentioned that the blood of *Æ. ehrenbergii* is pink; but pink is not a colour which is associated with the presence of hæmoglobin. With regard to the branched yellow cells described by Vejdovsky in the dorsal vessel of *Æolosoma*, I would venture to suggest that they correspond with the peculiar glandular structure which occurs in the dorsal vessel of *Otenodrilus* and of many other Annelids¹. In this case, the colouring-matter is probably not hæmoglobin². The absence, therefore, of a special respiratory pigment in *Æolosoma* renders it more possible that the pigment of the integumental glands may perform that function.

I imagine, from my observation of the living worm, that the pigment may also have a protective value. When a number of the worms are placed in a watch-glass with some of the vegetable débris upon which they feed, they are seen to hide themselves in this; the general colour of the worm is a faint brownish, which harmonizes very well with the colour of the substances upon which they feed and among which they live. When the worm is magnified these resemblances are hardly obscured; the worm is not unlike a slender stalk of some plant in which there are only fragments here and there of yellowish chlorophyll. It will be of interest to inquire how far the pigment of *Æolosoma tenebrarum* is related to the red pigment of *Æ. quaternarium* and *Æ. ehrenbergii*. I have applied the iodine test mentioned above to *Æ. variegatum*, but did not succeed in getting the black stain; the pigment of this species is of quite a different shade of green to that of *Æ. tenebrarum*.

EXPLANATION OF PLATE V.

Æolosoma tenebrarum.

- Fig. 1. An individual, from the ventral surface, with a young bud in course of formation: *pr*, ciliated prostomium of the young; the lateral ciliated pit is seen at *l'*; *l*, ciliated pit of the parent; *s*, short setæ of posterior segments.
2. Coloured epidermic cells as seen before the use of reagents: *o*, coloured oil-drop; *n*, nucleus.
 - 2*a*. Young coloured cell.
 3. Coloured epidermic cells after treatment with osmic acid: *n*, nucleus; *p*, cell-protoplasm forming a thin peripheral layer and rendered visible by shrinking of coloured oil-drop.
 4. Coloured epidermic cells after treatment with iodine solution.
 5. Débris of epidermic cells coloured violet on treatment with an alkali.
 6. Contents of coloured epidermic cells expelled by acid.
 7. Coloured epidermic cell showing shrinking of oil-body after treatment with osmic acid: *o*, oil-globule; *n*, nucleus; *p*, protoplasm.
 8. Setæ: *a*, of ventral bundles of posterior segments; *b*, transition between these and hair setæ.

¹ See J. T. Cunningham, "On some points in the Anatomy of *Polychæta*," Quart. Journ. Micr. Sci. vol. xxviii. p. 251, for an account of what is known of this organ in the *Polychæta*; also Eisig, "Die Capitelliden," Naples Monographs, xv. pp. 691, 692.

² Though possibly a derivative.